



EXPLORE

**Enabling a Near-Term
Interstellar Probe with the
NASA's Space Launch System**

Robert Stough
SLS Utilization Manager



SLS LIFT CAPABILITIES



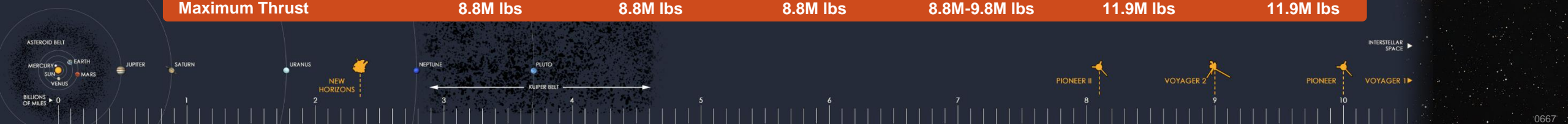
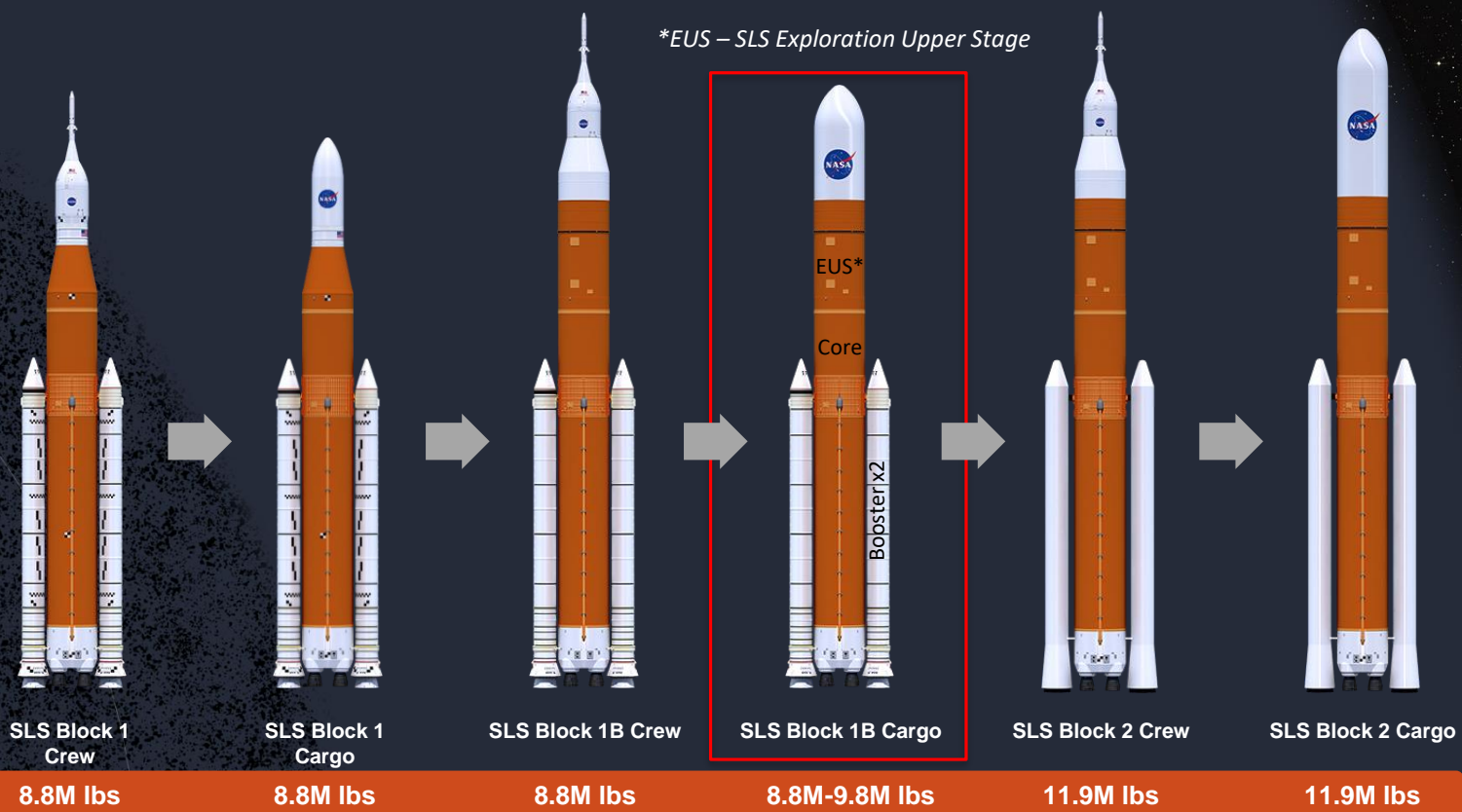
Payload to LEO	95 t (209k lbs)	95 t (209k lbs)	105 t (231k lbs)	105 t (231k lbs)	130 t (287k lbs)	130 t (287k lbs)
Payload to TLI/Moon	> 26 t (57k lbs)	> 26 t (57k lbs)	34–37 t (74k–81k lbs)	37–40 t (81k–88k lbs)	> 45 t (99k lbs)	> 45 t (99k lbs)
Payload Volume	N/A**	9,030 ft ³ (256m ³)	10,100 ft ³ (286m ³)**	18,970 ft ³ (537 m ³)	10,100 ft ³ (286m ³)**	34,910 ft ³ (988 m ³)

Low Earth Orbit (LEO) represents a typical 200 km circular orbit at 28.5 degrees inclination

Trans-Lunar Injection (TLI) is a propulsive maneuver used to set a spacecraft on a trajectory that will cause it to arrive at the Moon. A spacecraft performs **TLI** to begin a lunar transfer from a low circular parking orbit around Earth.

The numbers depicted here indicate the mass capability at the Trans-Lunar Injection point.

** Not including Orion/Service Module volume



SPACE LAUNCH SYSTEM: MORE VOLUME



CONCEPTUAL



Enclosure	5.1m PLF	8.4m USA	8.4m USA PLF	8.4m PLF, Short	8.4m PLF, Long	10m PLF
Type	5m PPL	8.4m CPL	8.4m PPL	8.4m PPL	8.4m PPL	10m PPL
Length	47.0 ft	32.8 ft	47.2 ft	62.7 ft	90 ft	90 ft
	14.3 m	10.0 m	14.4 m	19.1 m	27.4 m	27.4 m
Diameter	16.7 ft	27.6 ft	27.6 ft	27.6 ft	27.6 ft	32.8 ft
	5.1 m	8.4 m	8.4 m	8.4 m	8.4 m	10.0 m
Internal Diameter	15.1 ft	24.6 ft	24.6 ft	24.6 ft	24.6 ft	29.9 ft
	4.6 m	7.5 m	7.5 m	7.5 m	7.5 m	9.1 m
Available Volume	6,274 ft ³	10,100 ft ³	11,260 ft ³	21,930 ft ³	34,910 ft ³	46,610 ft ³
	177.6 m ³	286.0 m ³	319 m ³	621 m ³	988 m ³	1,320 m ³
Potential Availability (No Earlier Than)	COTS	2022	2023	2023	2024	2028

COTS: Commercial Off-the-Shelf CPL: Co-manifested Payload PPL: Primary Payload PLF: Payload Fairing



5m Fairing with Science Payload



Science Missions



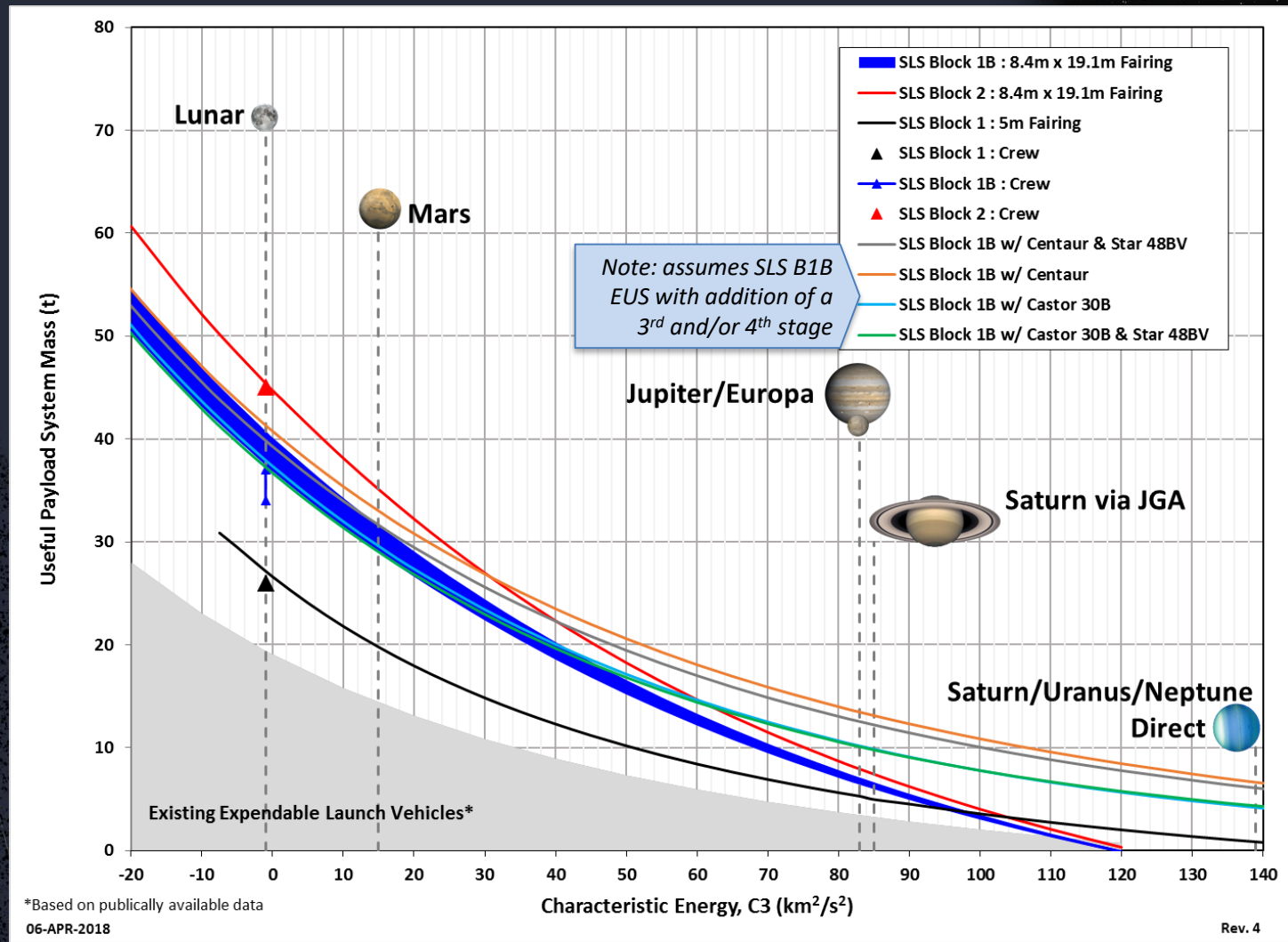
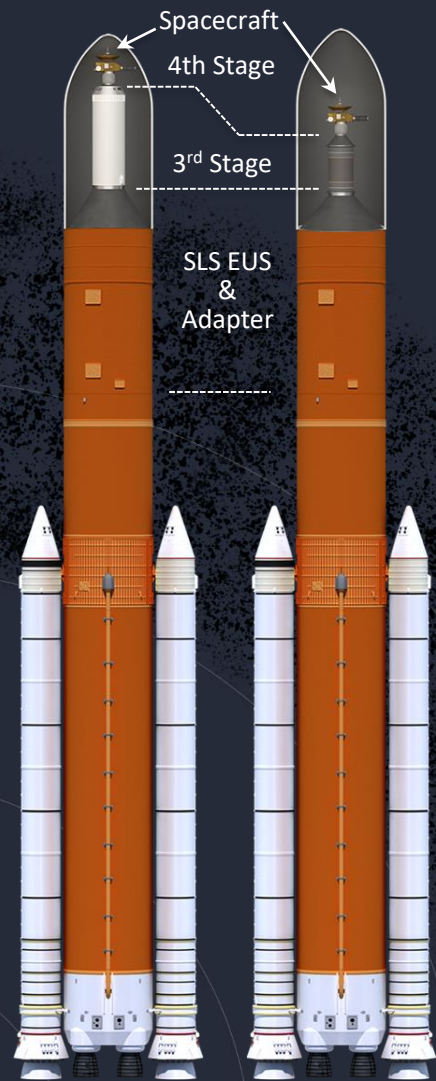
Orion with Science Missions



8.4m Fairing with Large Aperture Telescope



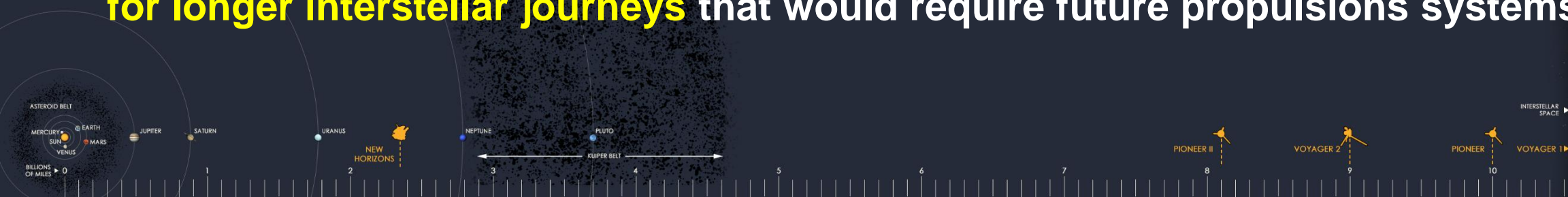
SLS 3RD/4TH STAGES INCREASE C3 PERFORMANCE



WHAT IS INTERSTELLAR PROBE?



- **“Interstellar Probe”** is a mission through the outer heliosphere and to the nearby **“Very Local”** interstellar medium or VLISM (up to 1000 AU)
- Interstellar Probe uses today’s technology to take the first explicit step on the path of interstellar exploration
 - **Heliosphere:** How does the heliosphere interact with our galactic surroundings?
 - **Kuiper Belt Objects:** Discover new worlds to understand the origin of our solar system
 - **Circum-Solar Dust Disk:** Reveal the unseen 3D dust distribution to understand planetary formation
- **Interstellar Probe can pave the way**, scientifically, technically, and programmatically **for longer interstellar journeys** that would require future propulsion systems



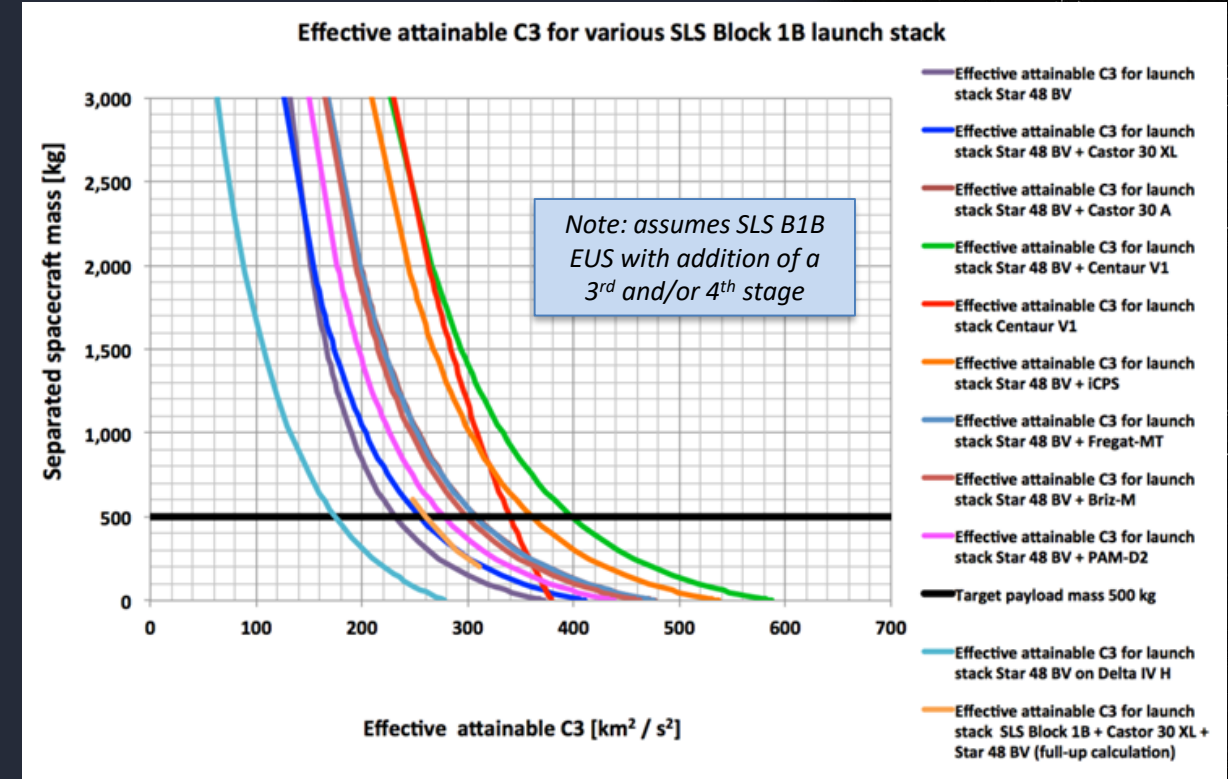
JOHN HOPKINS APL: INDEPENDENT LAUNCH VEHICLE STUDY



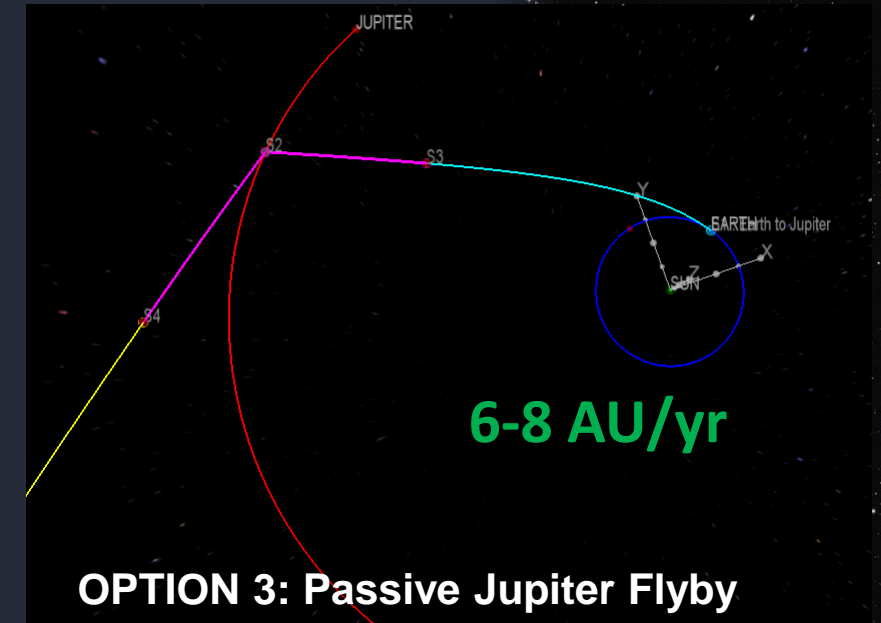
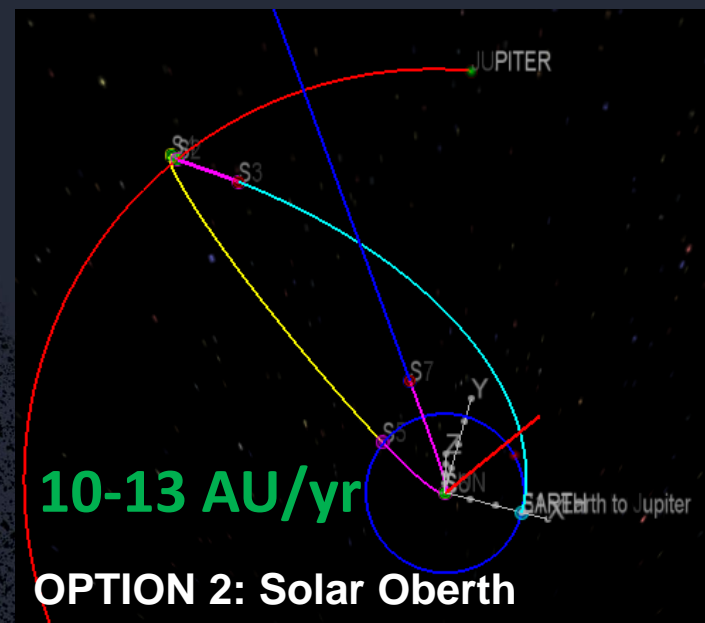
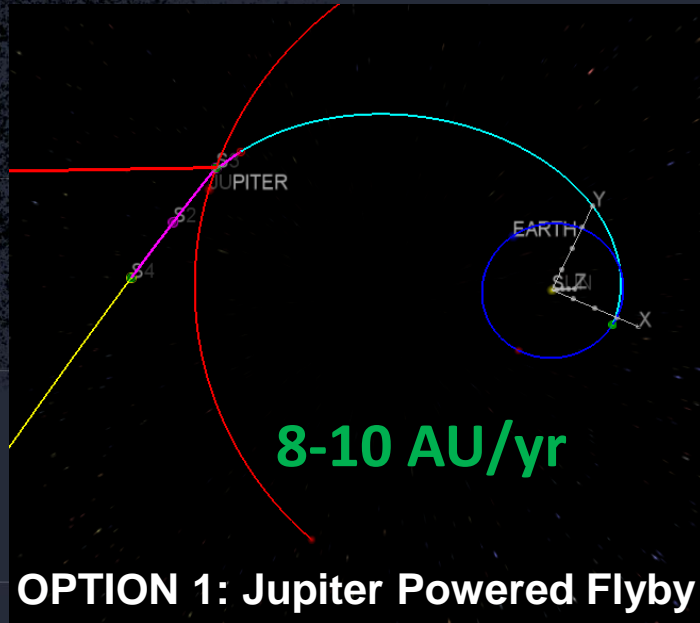
- **Key Decision Points**

- Asymptotic Velocity leaving the Solar System of 2x that of Voyager's 7.2 AU/yr
- $>300 \text{ km}^2/\text{s}^2$ launch energy
- Pragmatic approach to achieving high C3 energy
- Fit within typical spacecraft and payload constraints
 - Adequate payload, launch vehicle, and ancillary hardware margins for mass and volume

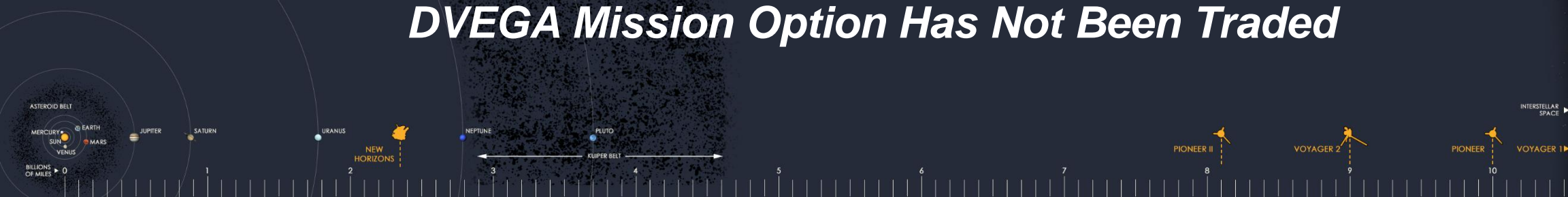
- **SLS was selected given that that it was the only vehicle to achieve C3s greater than $300 \text{ km}^2/\text{s}^2$**



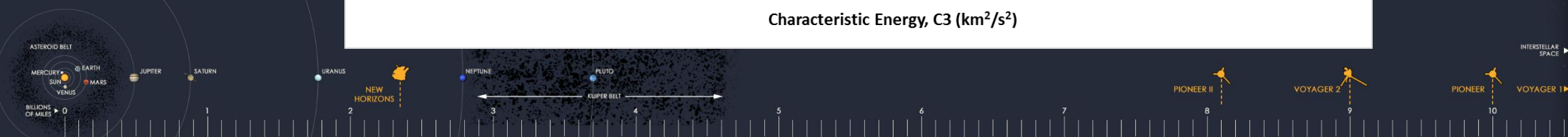
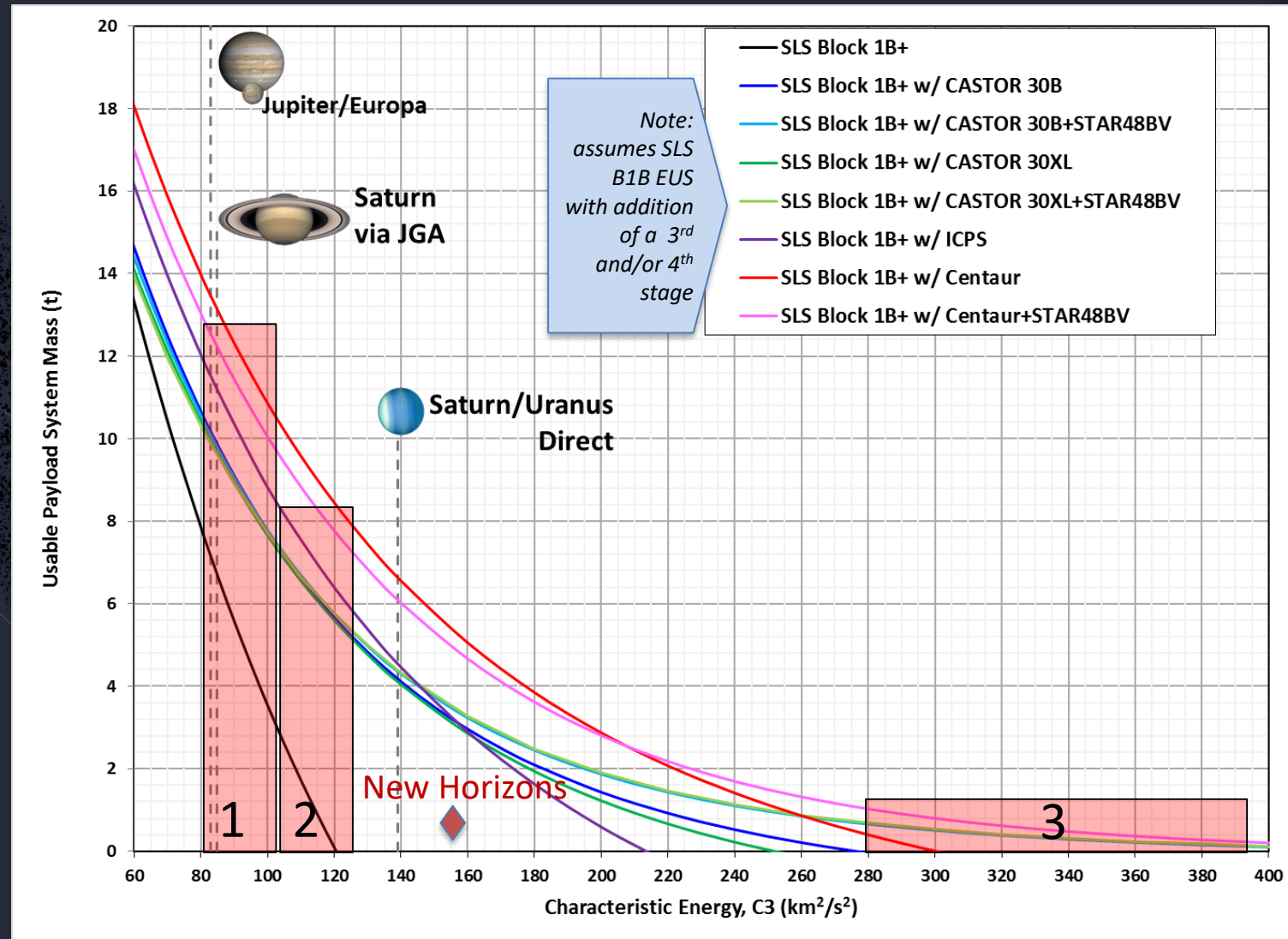
MISSION DESIGN OPTIONS



DVEGA Mission Option Has Not Been Traded



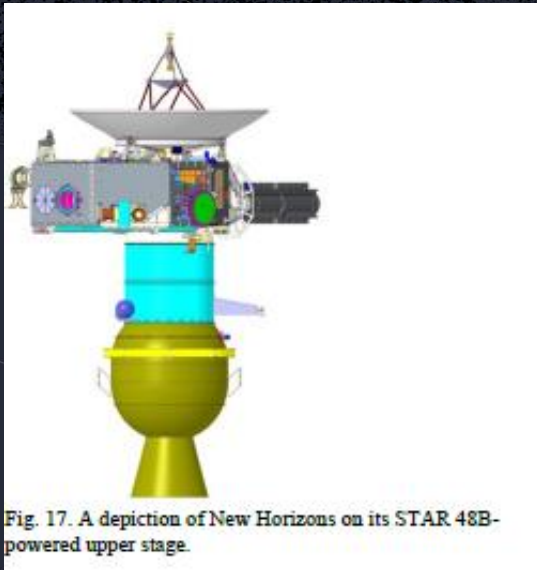
MISSION DESIGN OPTIONS



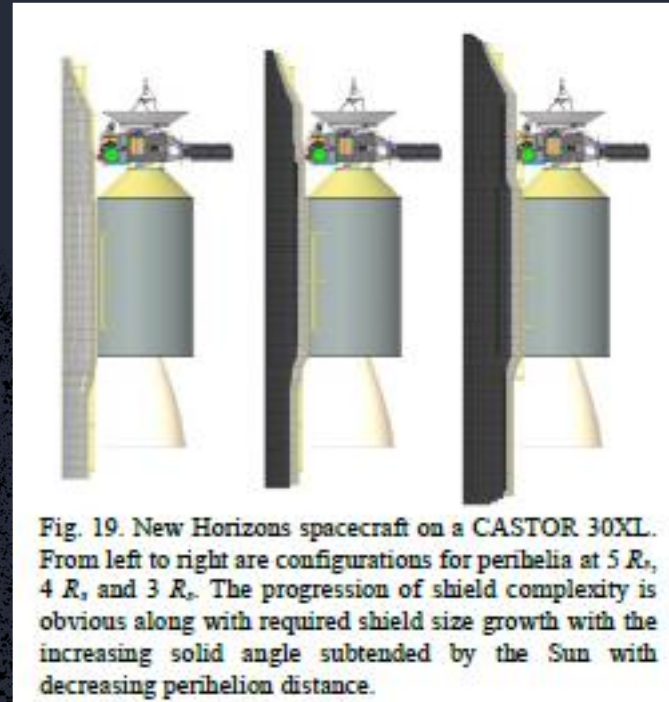
SPACECRAFT DESIGN



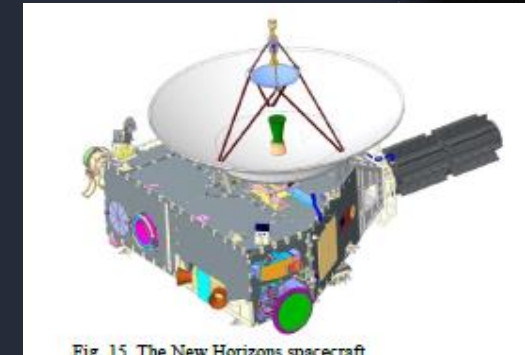
- Assuming a New Horizons-like spacecraft
 - Mass 400-900kg
 - Based on New Horizons, Pioneer, Parker Solar Probe, and Voyager Spacecraft
 - Targeting a 50-year lifetime
 - Ulysses/New Horizons RTG
 - Solar shield concepts developed by Parker Solar Probe Design Team



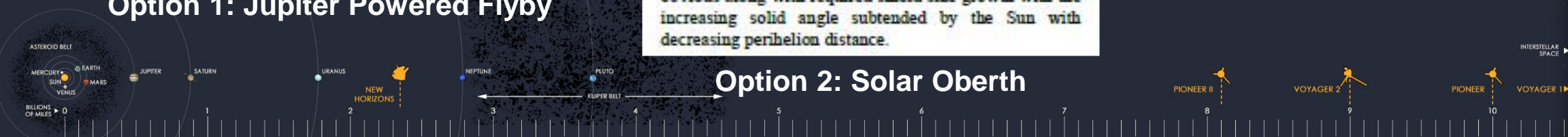
Option 1: Jupiter Powered Flyby



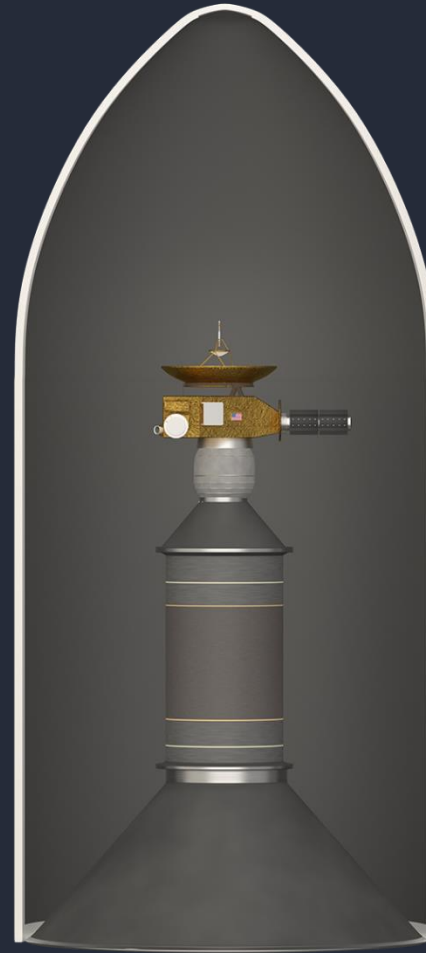
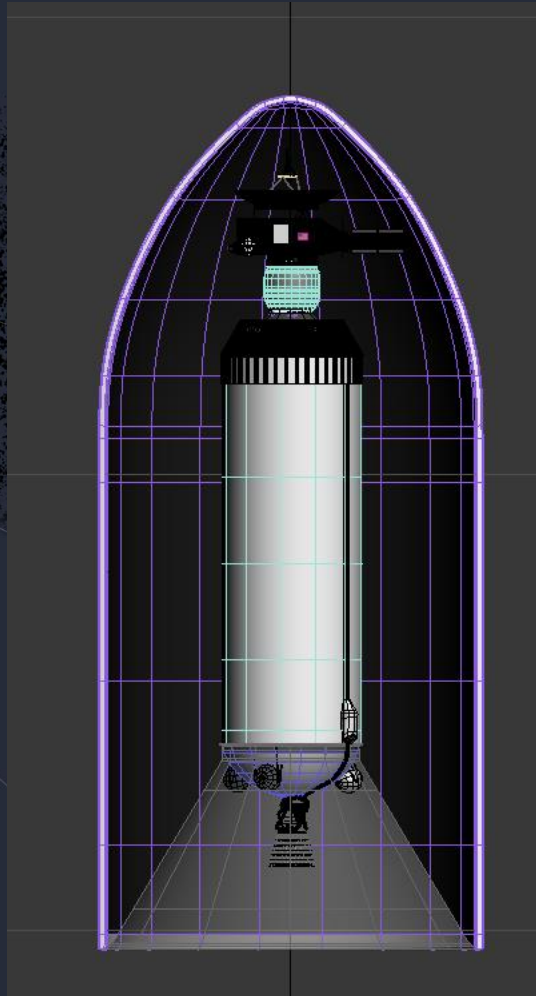
Option 2: Solar Oberth



Option 3: Jupiter Passive Flyby



INTEGRATED SPACECRAFT/ PAYLOAD ELEMENT PACKAGING



NOTIONAL PROJECT SCHEDULE



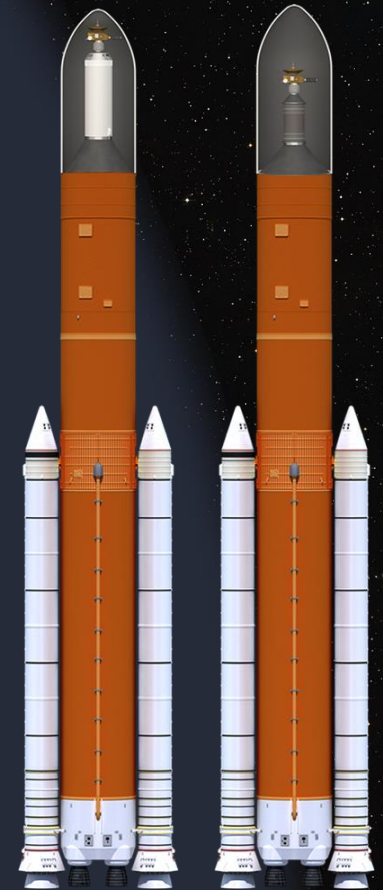
Interstellar Probe Parallels	L- Years	Notional Dates	Note: Dates are Task Start Dates	L- Months	L- Years	Parker Solar Probe
	11	1-Jun-18	Mission Formulation Start	132	11	
	10	30-Jul-18	Launch System Configuration and Performance Trades (start)	125	10	
	9	9-Jun-20	Engagement Studies with launch Vehicle and Stage Providers	103	9	
	9	9-Jun-20	Launch System Configuration, Trajectory and Performance Trades (w/NASA KSC)	103	9	
	9	9-Jun-20	Spacecraft Phase "A" Start	103	9	
	8	2-Mar-21	ISP Performs Program Cost, Performance, and Risk Trade Studies	94	8	
	7	24-May-22	Spacecraft Phase B Start	79	7	
	3	6-Aug-25	Launch Chicken system Selection (by NASA)	41	3	
	3	6-Aug-25	Spacecraft Mission Phase C Start	41	3	
	2	20-Sep-26	Spacecraft Integration and Test Start	27	2	
	1	15-Feb-28	Spacecraft Environmental Testing start	11	1	
	0	27-Jul-28	Launch Campaign Start at the Launch Site	5	0	
		1/1/2029	Launch Date	0	0	



SLS ENABLES SCIENCE



- SLS is America's heavy-lift vehicle for strategic human exploration and scientific missions
- Manufacturing is complete for the first flight; SLS is nearing the integration phase
- SLS has a flexible architecture and an evolvable upgrade path
- Discussions with the science community are ongoing to determine how SLS can enable breakthrough science missions, such as sending a probe to interstellar space
- **SPIE serves as a front door for parties interested in flying SLS; in addition to Interstellar Probe, we are working with Europa Clipper and Lander, Gateway, Human Landers, CubeSats, space-based solar power, large telescopes, and others**



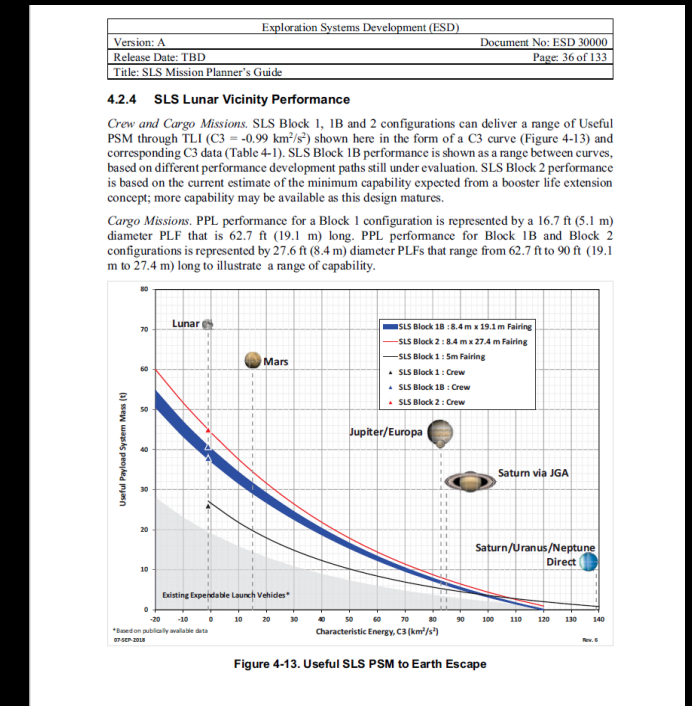
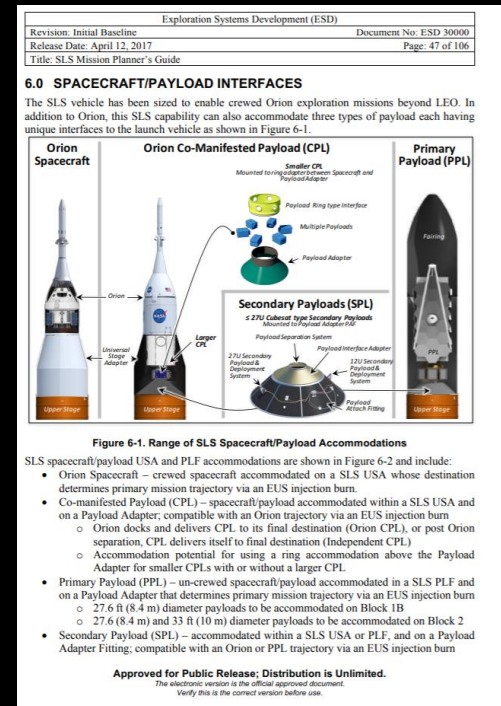
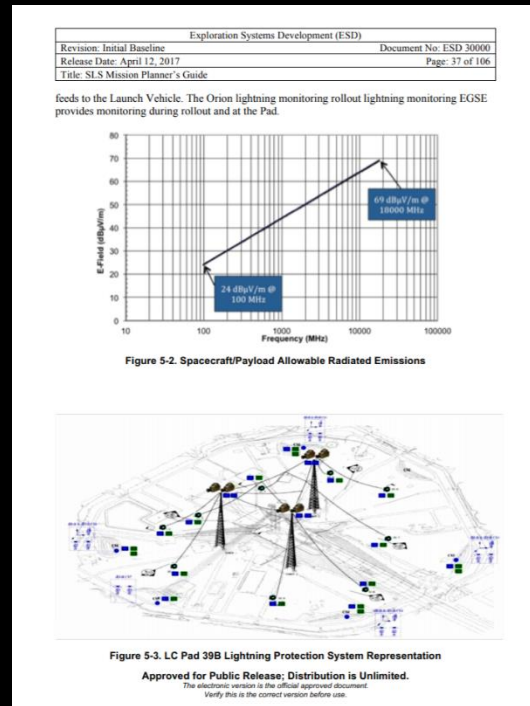
MORE TECHNICAL INFORMATION

SLS MISSION PLANNER'S GUIDE



- **SLS Mission Planner's Guide (ESD 30000)**

- Google or email: NASA-slspayloads@mail.nasa.gov
- www.nasa.gov/opportunities for payload opportunities and announcements



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